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REPORTS
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Assessment of Methods to Project Economics Demand For USFS Range Outputs

msu DEPARTMENT OF AGRICULTURAL ECONOMICS & ECONOMICS

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COLLEGE OF LETTERS & SCIENCE

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January 14, 1982

MEMORANDUM TO: Fred J. Wagstaff
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735 North 500 East
Provo, Utah 84601

FROM: C. Robert Taylor CRT
Bruce R. Beattie BRB

RE: Final report on co-op agreement INT-81-061-CA (MSU)

Attached is our final report on "An Assessment of Methods to Project Economic Demand for USFS Range Outputs. This version of the report incorporates suggestions made during our December 10, 1981, meeting in Bozeman. In particular, we attempted to state our assessment and our recommendations in a less subtle manner. Please let us know if you would like any parts of our report clarified.

We have enjoyed working with you on this project and hope that we can work on cooperative research in the future.

/dsd

cc: Ed Frandsen
Terry Raettig
Irv Shuster
Jack Weeks

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AN ASSESSMENT OF METHODS TO PROJECT ECONOMIC DEMAND FOR USFS RANGE OUTPUT

C. Robert Taylor
Bruce R. Beattie

Completion Report
Cooperative Agreement INT-81-061-CA (MSU)
Submitted to
USDA, Forest Service
Intermountain Forest and Range Experiment Station
507 25th Street
Ogden, Utah 84401

Department of Agricultural Economics & Economics
Montana State University
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January, 1982

AN ASSESSMENT OF METHODS TO PROJECT ECONOMIC DEMAND FOR USFS RANGE OUTPUT

C. Robert Taylor

Bruce R. Beattie*

The purpose of this report is to provide a state-of-the-art knowledge base to improve estimates of projected economic demand for Forest Service (FS) range outputs. Also covered in the report is the inseparable issue of determining the level at which the FS should set grazing fees. It is our understanding that the needs of the FS are for regional and forest level projections of range demand and fees.

This report is divided into five parts. The theory of derived demand and the demand for rangeland is conceptually examined in section 1. The second part addresses inherent problems in direct estimation of the demand for FS rangeland. An alternative conceptual and empirical approach is presented in section 3. The fourth section presents an assessment of existing models that could be used for projecting the demand for FS range. The final section of the report suggests studies that would increase the information base needed to set grazing fees for FS rangeland.

1. Theory of derived factor demand--a brief review

The economic demand for FS range, like the demand for any other factor of production (input on resource) is a derived demand. That is, the demand for range as a forage input in the production of cattle and sheep exists

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because of consumers ultimate demand for red meat and wool. Conventional economic theory holds that the aggregate demand for a resource is the summation of individual firm demands for that resource. Hence the mathematical expression representing that demand will be a function not only of the price of the resource in question but also of the prices of those variable inputs used conjectively, quantities of any fixed factors and the price of the product produced. As such, the derived demand for a particular input depends not only on its productivity and that of related inputs but on the supply of related inputs as well. If markets exist for the related inputs (fuels, alternative feed, labor, etc.) and the output (feeder calves, grass-fed beef and/or lambs) then price information is generally readily available and the decision-maker takes this information into account in deciding how much FS range to use (demand) in combination with other inputs.

In the long-run, i.e., a production planning horizon of sufficient length that all related outputs are variable, we would expect the demand for FS range to be given by

(1) $X_1 = f(r_1, r_2, \ldots, r_m, r_{m+1}, \ldots, r_n, P)$

Where X_1 is the quantity of FS range demanded; r_1 is the price of FS range, say per AUM; r_2 through r_m are prices of related (substitutes or complementary) feed stuffs; r_{m+1} through r_m are prices of other relevant inputs (e.g., labor, management, fuel, veterinary services); and P is a vector of relevant product prices. If a rancher adopts a shorter-run planning horizon then certain inputs may, in effect, be considered fixed in which case

(2) $X_1 = f(r_1, r_v, X_s, P)$

where X_1, r_1 and P are as defined previously; r_v is a vector of prices of those inputs that may be altered in quantity during the course of the planning period; and X_s is a vector of input quantities that are considered fixed.

Generally we expect that factor demand functions will have the following properties:

(1) own-price effect is negative, i.e., $\partial X_1/\partial r_1 < 0$

(2) cross-price effects are negative for complementary inputs and positive for substitute inputs, i.e., $\partial X_1/\partial r_i \lesseqgtr 0$

for i = 1, ..., m

(3) fixed-factor effects are positive, i.e., $\partial X_1/\partial X_s > 0$; and

(4) product-price effect is positive, i.e., $\partial X_1/\partial P > 0$.

Of course, in real world production situations many of the productive inputs are "minor" and often not considered in empirical prototypes of equations (1) and (2). Also data availability and statistical necessity frequently suggests an operational model of only two or three input price variables, a limited number of fixed factors and perhaps a single (composite) product price variable; aggregate price indices are often times resorted to as a matter of necessity. Clearly direct estimation of abbreviated versions of (1) and (2) requires that one have a robust data set for all the relevant price and quantity variables. As we will see in the next section the direct estimation of FS range demand is effectively precluded because of this problem. Not only is there not much variability in the data set, the most critical data (i.e., market value of FS range) is not available. We will show that FS range prices do <u>not</u> lie on the ranchers relevant demand function for FS range!

2. Direct Empirical Estimation of the demand for FS rangeland: Why it cannot be done

It is generally agreed that the ideal approach to problems of this type is to econometrically estimate demand and supply relationships on the basis of time series observations on prices, quantities, and exogenous variables which shift the relationships over time. In the case of FS range demand, however, appropriate price-quantity observations are not available and will not be available as long as price is administered as opposed to being determined by market forces. Although data are available on FS lease rates and range usage, these are not appropriate data for econometric estimation as is illustrated in figure 1. Since lease rates have been below market rates, all time-series observations pertaining to FS range demand lie below the true demand function for FS rangeland (figure 1). Therefore, econometrically fitting a function to lease rate-quantity observations will not yield a function that can be interpreted as a demand curve. Thus an econometric approach, such as that appropriately used in the Haynes-Adams timber model, is not applicable to FS range demand estimation.

3. Demand for FS range--a closer look and an empirically workable approach

Before examining various models that could be used to predict the demand for range, it is imperative that we more closely examine the nature of the demand for range in conceptual and practical terms. As noted earlier, conceptually, the demand for range is derived from the demand for products which are produced from range--principally weaner calves and sheep. Since land is the major fixed factor in the production of livestock on range,

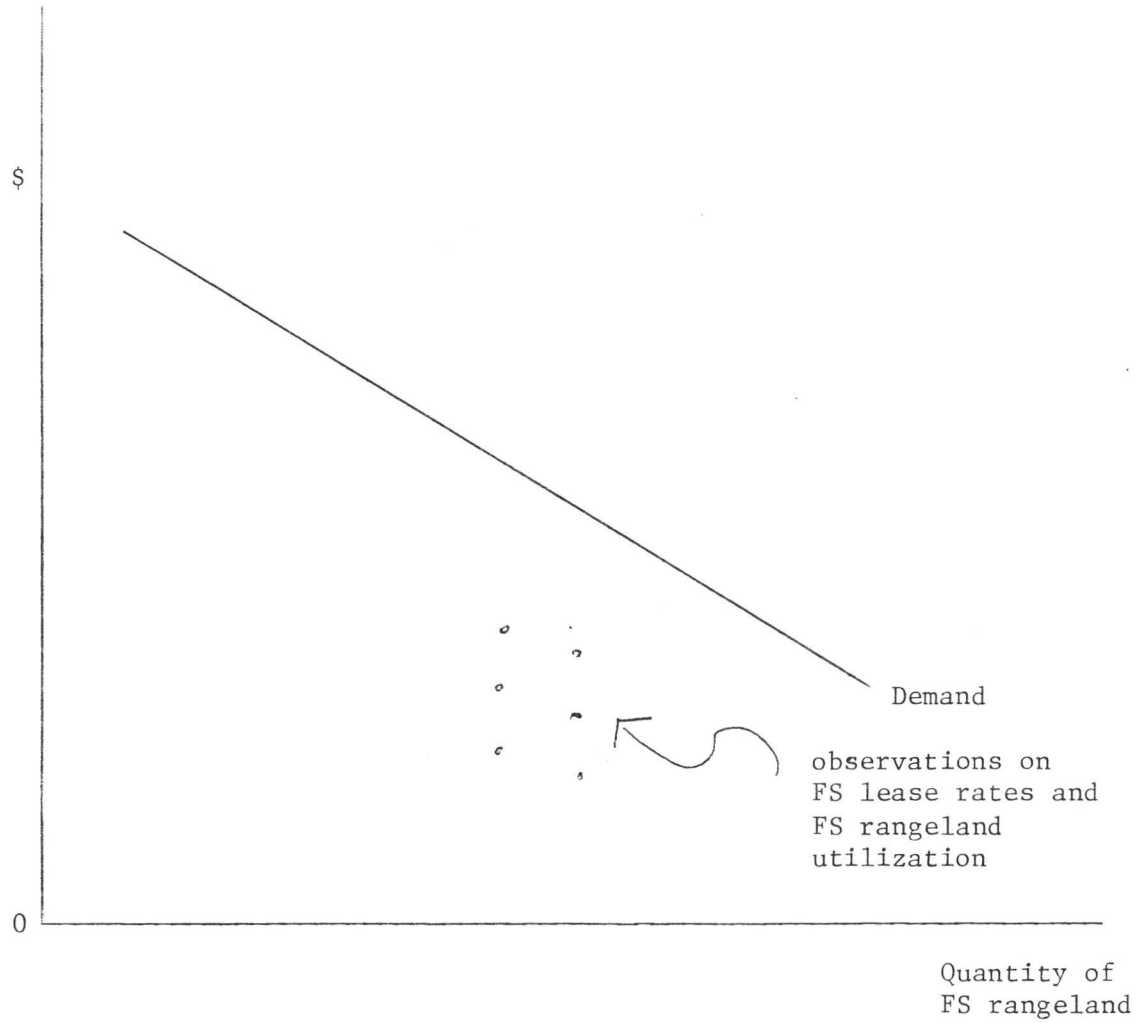
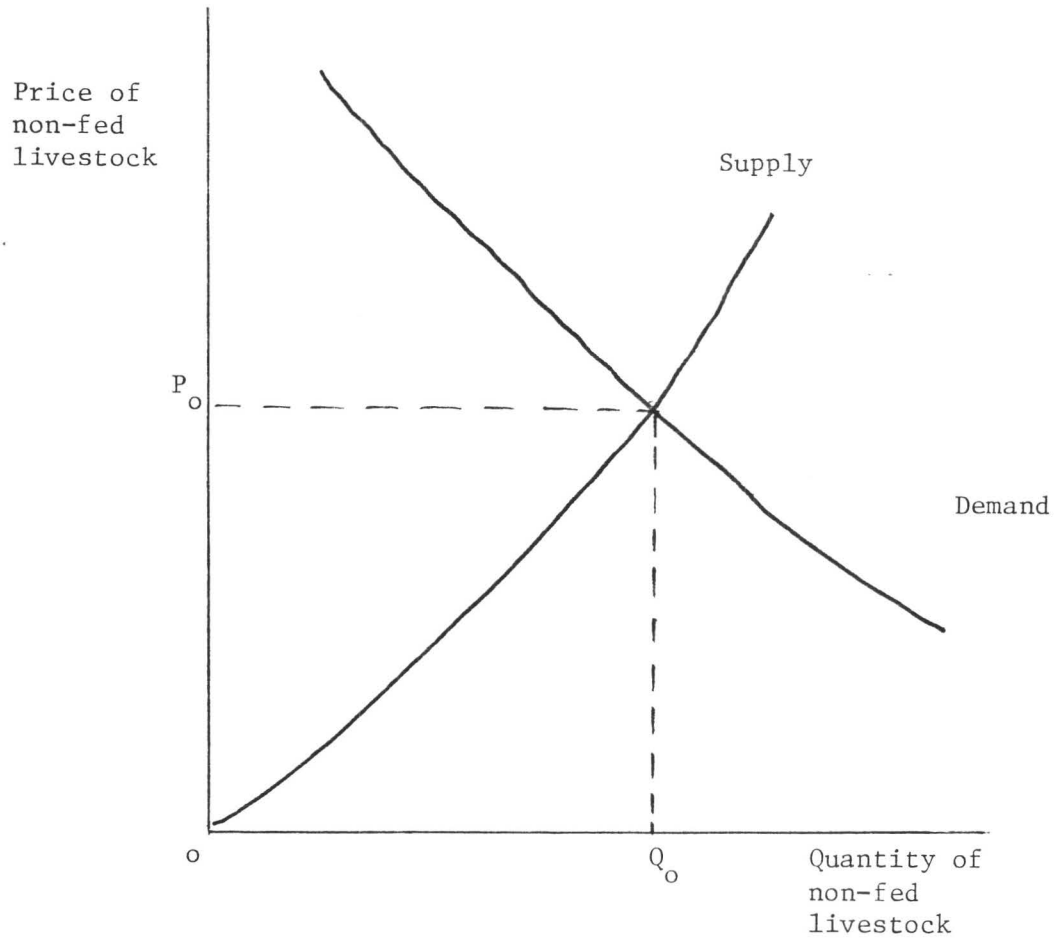


Figure 1--An hypothetical illustration of the demand for FS rangeland versus lease rate-quantity observations.

any returns above non-land production costs accrue to land. Because the demand for range is a derived demand and because the price issue is tied to a return to a fixed factor, the whole demand-pricing issue is something of an elusive concept. Also, in the context of RPA range assessment, demand may be loosely construed as "how much of the range will be used" under various conditions.

The demand-pricing issue is more easily sorted out if we first assume that all rangeland is privately owned. Then we can side-step the issue of grazing fees vs rents accruing to land. Assuming that all land is privately owned, consider the hypothetical non-fed livestock supply and demand functions shown in figure 2. Market equilibrium is achieved at a price of P_o and a quantity of Q_o. To project future conditions, we need to consider both shifts in supply and demand. First consider shifts in the demand for non-fed livestock and how this affects rangeland utilization. If production of non-fed livestock on rangeland is associated with the upper portion of the supply curve, then it can be seen in figure 1 that shifts in demand will indeed affect rangeland utilization--increases in livestock demand will increase rangeland utilization and vice versa for decreases. If, however, production from rangeland is associated with the lower portion of the supply curve (and the upper portion is associated with production from other forage sources), then fairly wide shifts in demand will not influence rangeland utilization. Change in factor prices which shift the supply curve, can also influence the economic position of rangeland relative to other forages.


Price of
non-fed
livestock
Supply
P_o
Demand
o
Q_o
Quantity of
non-fed
livestock

To the authors' knowledge, the critical issue of the segment of the supply curve for livestock that is attributal to rangeland has not been adequately addressed. It would appear that some production costs are, in general, greater on rangeland because of greater losses due to noxious weeks, limited access, predation and other factors. However, opportunity cost on most rangeland is very near zero, while opportunity cost for other land, say that used for improved pasture, is positive. The net effect of relatively higher production costs, but lower opportunity costs is not clear. Nevertheless, we believe that livestock production on rangeland accounts for the intra-marginal (lower) segment of the livestock supply curve for a wide range of livestock demand and relative factor price conditions. If this is the case, the forecasting models that are discussed in a later section of this report will be of very little value for RPA assessment.

Let us now closely examine the nature of the derived demand for rangeland, considering only FS land. Again, we initially consider a free market, then address the issue of appropriate FS grazing fees.

The upper chart in figure 3 illustrates a supply function for livestock produced on FS rangeland. To simplify graphical exposition, the quantity of livestock is interpreted in terms of common units with rangeland, say AUMs. When capacity of the FS range is reached at Q_c, the supply curve becomes vertical.[1/] Below capacity, the supply curve is shown to have a positive slope to reflect differences in quality of rangeland as measured by per unit production costs. Demand for livestock

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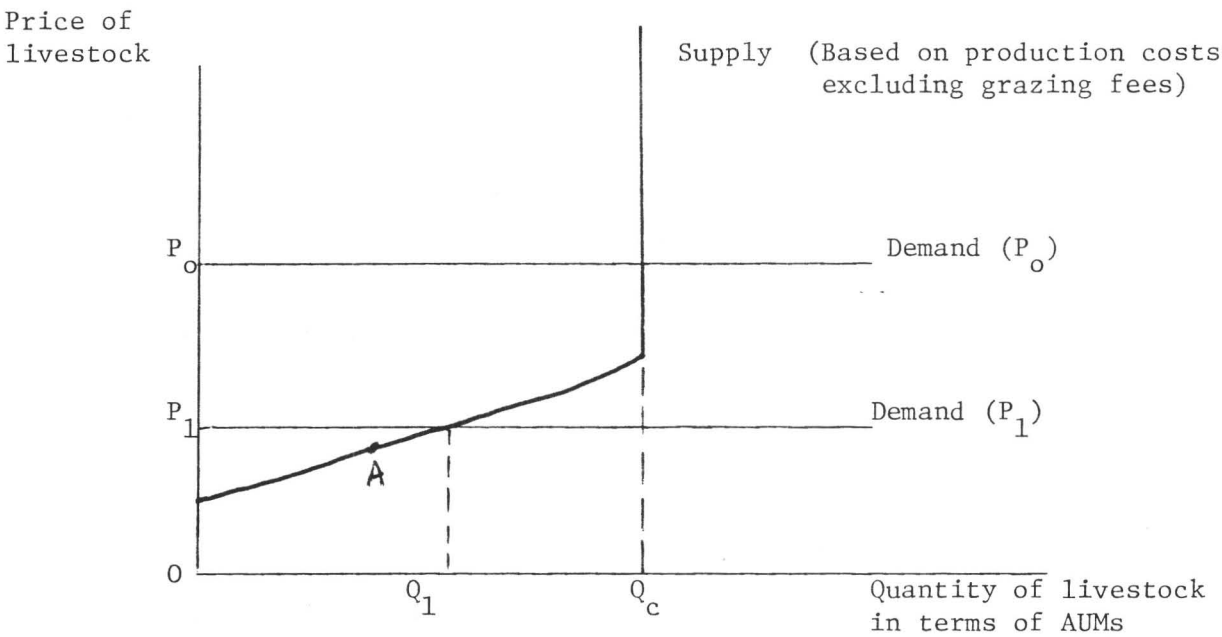
[1/] Of course with the possibility of timber and conversion to rangeland, the long-run supply curve would not be vertical at Q_c. But for purposes of this discussion it is useful to abstract from that issue.



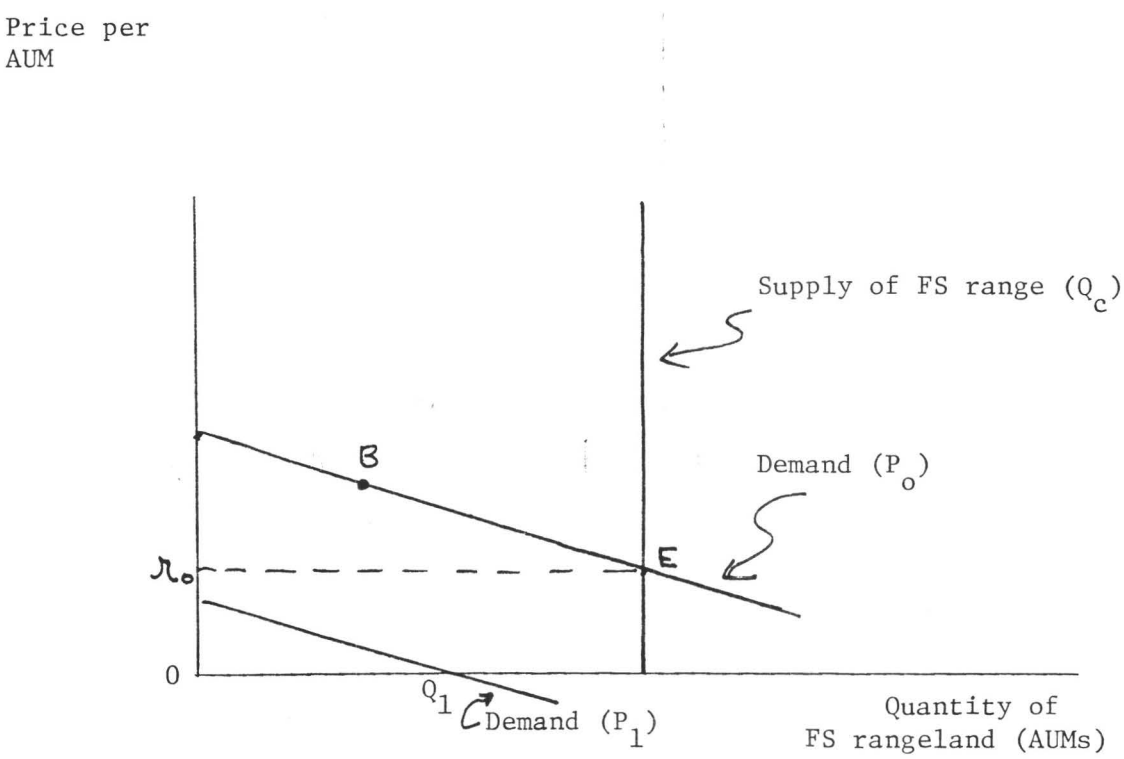


Figure 3-- hypothetical derived demand for FS rangeland.

is shown as perfectly elastic since production on FS land accounts for a very small part of national production; the demand curve could be shown as negatively sloped without affecting the logic of deriving range demand.

The lower panel in figure 3 shows the derived demand for FS rangeland, with a different demand schedule for each livestock price level. Derived demand (lower panel) is obtained simply as the vertical difference in the demand and supply of livestock (upper panel) for each quantity of rangeland (AUMs). If livestock price is P_1, then Q_c units of rangeland would be utilized in a free market; if price is P_o then Q_1 units will be used. To achieve a level of resource allocation with public ownership of the land that is consistent with market efficiency, the FS has two options. Assuming that livestock price is P_o, one option is to set grazing fees at r_o. At the margin (Q_c) the lease rate would just equal the difference in per unit livestock price and per unit production cost, while to left of Q_c a positive net return would accrue to producers. A second option is to charge a lease rate as reflected by the demand curve in the lower panel; that is, set fees as would a price discriminating monopolist. Both options result in the same use of rangeland, but the latter option extracts the same rent as would be extracted by private owners of land.

A point made earlier is that FS rangeland is likely associated with the lower segment of the national supply curve for non-fed livestock. In the context of figure 3, this argument implies that it would take an extremely low livestock price before less than Q_c units of rangeland would be demanded, i.e., a price lower than that associated with the "kink" in the supply schedule of figure 2 (top panel).

The advantage of looking a FS range demand in the context suggested here rather than the conventional view represented in section two is that this framework is empirically operational whereas the conventional view (approach) is not. An empirically workable approach would be to construct forest-specific demand functions for FS rangeland on the basis of comparative cost-of-production budgets for specific situations in each area. Existing FEDS budgets are not forest specific; therefore, they are of limited usefulness in the determination of FS range demand. Also, cost studies now being conducted by Kerry Gee are only partially useful because they will yield only a single average production cost on FS range for each forest. In terms of figure 3, Gee's work will give point A in the upper panel, which translates into point B on the demand curve in the lower panel. It can be seen that several points on the livestock supply curve are needed to establish demand functions for FS rangeland. As will be addressed in more detail in a later section, Gee's work can be expanded to obtain the additional information required to establish demand functions for each forest.

4. Assessment of existing models

Existing models that were assessed for their applicability to range demand projections were: (a) USDA's NIRAP model, (b) Professor Earl Heady's national linear programing (LP) models; and (c) the Data Resources Inc. (DRI) econometric model. Other models were briefly examined, but were found to be less applicable than the three above models; thus, these other models are not discussed in any detail here. Suffice it to say that the Haynes-Adams model will not work for FS range demand estimation because (as

noted earlier) it requires data that are not, and will not be, available for FS range. The other models examined are less applicable to FS range demand projections than the models discussed.

The three models that were carefully assessed represent the three major types of quantitative models that can be used for making projections. The DRI model is a "positive" econometric-simulation model, Heady's models are "normative" activity analysis models, while NIRAP is a hybrid model that combines some features of the other two models. All models, with the possible exception of some of Heady's LP models, do not explicitly account for rangeland. Rather, the demand for rangeland must be based on the demand for livestock or the demand for all roughages. As a result, the accuracy and applicability of the models for range demand predictions are limited; however, data limitations do not allow a more direct approach to range demand projection.

General comments on each of the models follow.

NIRAP

An executive brief on NIRAP[2/] states that the model is "ERS's" barn door for calculating long-range prospects for food and agriculture." In our opinion, ERS has indeed succeeded in building a barn from the roof down. And while such an approach may result in something resembling a barn, it would not be advisable to even get near the door!

NIRAP projections are made with a top-down approach: Two equations

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2/ Comments on NIRAP are based on a draft report by Chun-Lan Liu, G. Plato and A. G. Smith entitled "The Demand for Grazing Roughages in the United States: Alternative Futures to the Year 2030."

are used to predict indices of aggregate agricultural supply and demand. These aggregate projections are then disaggregated into individual commodities, which are then apportioned to regions. Disaggregation is accomplished by a hodgepodge of methods, including regression, mathematical programming, professional judgment, and "guesstimation".

Aggregation biases inherent in the two equation approach to aggregate agricultural output estimation are legion. Nevertheless, a two-equation approach provides a simple method for making ball park projections of aggregate output--but only of aggregate output. If, however, individual commodity and/or regional projections are desired, the top-down, two-equation approach is unsatisfactory. In addition to the aggregation bias, there is a disaggregation bias, and it is highly unlikely that the two types of bias net out to zero. Moreover, in the case of NIRAP, the disaggregation procedure is not firmly based on behavioral and interregional competitive relationships.

Aside from problems with the top-down approach, there are serious problems with the two equations that form the heart of NIRAP. Problems include:

(1) The specification of the two equations is inconsistent with elementary economic theory: In the demand equation, the price elasticity of demand is not equal to the negative of income elasticity; the price expectation model is questionable since expected price is an exponential product of past prices, rather than a weighted sum of past prices; and increasing all prices by a constant proportion (i.e., pure inflation) will result in output changes--contrary to established economic theory.

(2) Parameters of the model were not statistically estimated, perhaps because the model has the dependent variable on both sides of the equation, which would result in biased and inconsistent parameter estimates if ordinary statistical procedures were applied. Yeh states: "After a considerable number of simulation runs and in particular after considering the ability to predict the 1967-74 historical period, it was decided to use 0.20 as the short-run elasticity and 1.0 for the long-run elasticity with the lag parameter in supply equal to 0.20."

To use another metaphor, if you twist enough dials on the computer, you can duplicate any historical time series, but there is no assurance that you have identified the structure of the process you are trying to model--a structure which, in our opinion, is necessary to make well-informed projections.

Because NIRAP is computerized, it may superficially appear to provide an objective means of making agricultural projections. However, projections from the model are just as subjective as back-of-the-envelope projections, and may be less accurate than projections obtained by much simpler approaches.

To summarize, NIRAP simply crunches numbers. There is no evidence that an effort has been made to determine with scientific rigor the structure of the agricultural economy. And, without high quality information on the structure of the economy, we see no way to make informed projections on the future path of the economy.

Range Demand Component of NIRAP

With NIRAP national projections of the demand for grazed roughage are allocated to states and to types of livestock by a goal programming

algorithm. The goal programming algorithm solves a multiple objective problem by minimizing the non-attainment of all goals subject to non-goal constraints. For NIRAP, all goals and the priority of goals are subjectively specified. In addition, interstate shipments of roughages were subjectively specified to "give each State more realistic results." Thus, the crux of the range demand component of NIRAP is that it is a mathematical way of making highly subjective projections and allocations to regions and livestock categories.

A September 26, 1978 draft of the grazed roughage demand projections from NIRAP lists several needed changes that are especially troublesome. First, they state that "it is important that the FS determine the supply potential of range grazing prior to the establishment of grazed roughage demand." This statement causes concern because demand has nothing to do with supply, although long-run supply does depend on demand to the extend that range improvements depend on livestock prices. To say that supply must be determined prior to demand is simply ridiculous. For projections, it is necessary to know both long-run supply and demand; the quantity that will be demanded and the associated price will be given by the intersection of these two relationships.

The needed changes section of the draft report also contains some troubling and invalid policy recommendations for FS rangeland. The authors argue that the FS should act only "to make up the short falls between the output of the private sector and the ever changing levels of demand." They argue further that "this role allows the FS to (1)

maximize Federal contributions to the overall well-being of the nation, but, (2) minimize Federal intervention in the private sector." First, is it well known that it is logically impossible to optimize two objective functions with only one control variable (Federal rangeland). Secondly, elementary economic theory clearly demonstrates that controlling Federal rangeland as the authors suggest will not "maximize Federal contributions to the overall well being of the nation." In another paragraph, the authors contradict themselves by stating that "the FS should consider moving toward letting the market determine the supply level."

Heady's LP Models

Professor Heady and his research group have several versions of national LP models of US crop and livestock production. For purposes of this report, a single version of the models that is fairly representative of Heady's approach, was selected for discussion.[3/]

Description of Heady's Model

The objective function in the LP model is the area between stepped demand functions and stepped supply functions for crops and livestock. Maximization of this area results in normative (what should occur under proft maximization) market clearing prices and quantities for individual crops and types of livestock. This objective function is optimized

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3/ The version considered is published, in part, in an article by W. G. Boggess and E. O. Heady entitled "A Sector Analysis of alternative Income Support and Soil Conservation Policies," published in American Journal of Agricultural Economics 63 (Nov. 1981): 618-628. Much of the above discussion is paraphrased from this article.

subject to a set of resource constraints on the model including acreage of dry and irrigated land available for production of the endogenous crops, acre-feet of water available for use by endogenous crops and livestock, commodity balance rows, a national cotton demand equation, and the constraints associated with the stepped formulation of the demand equations.

In order to represent the interregional competitive aspects of U.S. agriculture, the major constraints and demands on the agricultural production sector are formulated regionally. Three sets of regions are defined in the model: the crop production regions, the livestock production and market regions, and the endogenous demand regions.

Crop production activities and the land base are defined for 105 producing areas. Livestock production activities and the exogenous commodity demands and exports are defined for 28 market regions. The market regions are aggregations of contiguous producing areas.

Eight endogenous demand regions are aggregations of contiguous market regions. Each demand region is the demand and transportation center for the endogenous commodities. Metropolitan centers in each region form the model's transportation sector.

The demand sector consists of three categories: (a) demands for endogenous commodities for which equations are specified, (b) fixed demand for the endogenous crop, cotton, and (c) demands for exogenous commodities. Each of the three demand categories incorporates net export, domestic consumption, and intermediate uses.

The cropland base is derived from the Conservation Needs Inventory (CNI), which reports acres of land by use and agricultural capability

class (Conservation Needs Inventory Committee). The CNI county acreages are aggregated for dryland and irrigated uses into the 105 producing areas and into 5 quality classes. The 5 quality classes are aggregations of the 29 CNI agricultural capability classes and sub-classes. The CNI capability class and sub-class distinctions are based on the relative suitability of the land for agricultural production purposes.

The crop sector contains barley, corn, corn silage, cotton, legume hay, nonlegume hay, oats, sorghum, sorghum silage, soybeans, and wheat. Unique production activites are defined for each of five land quality classes in each of the 105 producing areas.

The livestock sector consists of beef cows, feeders, dairy, and hogs. Several alternative rations, reflecting optimum input ratios for alternative output levels and price ratios are specified for each type of livestock. Activity costs include all production costs except feed, which is endogenously determined.

Applicability of Heady's Model

Heady's model is designed for impact analysis rather than for making long-run projections. As a practical matter, baseline solutions for LP models such as Heady's model seldom give national price-quantity solutions that are highly realistic. However, under certain conditions, changes in prices and quantities estimated with national LP models have more realism than the absolute price-quantity estimates. Thus the models are useful for certain types of impact analysis. Given that the FS needs accurate baseline projections of prices and quantities, it would appear that Heady's model is not well suited to their needs.

Another major shortcoming of the LP approach is that the linear structure results in stair-stepped supply functions. The size of these steps is reduced in Heady's model by dividing land into groups of soil types. Nevertheless, at the regional level this linearity results in a model solution that tends to produce only one activity on a particular soil group. And, slightly changing the coefficients in the model may cause a complete shift in the model results in a particular region, which is quite often an unrealistic outcome. To prevent extreme shifts of this nature, some modelers limit activities with artificial "flexibility" constraints. Although Heady does not report flexibility constraints, an inspection of model results for various policies suggests that they may indeed be in the constraint set. In either case, model results at the producing region level are seldom realistic. Consequently, model results at the regional level are questionable, suggesting that the model is of limited applicability for regional projections of the demand for FS range.

DRI's Econometric Model

The DRI[1/] econometric model is a large-scale, well developed model of the agricultural sector. The livestock component of the model is national, but is based on behavioral relationships for specific types of livestock operations and economic size classes for producers. Imbedded in the livestock model are appropriate production and price cycles that have been historically observed. The livestock model is endogenously linked to a regionalized crop production and consumption model, and to a national hay market model.

1/ Comments on the DRI model are based on material supplied by DRI and personal correspondence with Fred Arnold.

DRI's model has the capability for projections for making quarterly, annual, and long-run projections. The model is updated on an annual basis.

Range demand is not explicitly modeled. Any projections of range demand would have to be based on cow-calf inventory, sheep inventory, and non-fed beef production.

Although the livestock model is national, DRI has the capability for making projections at the state level. However, these state level projections are based on shift-share (i.e. proportional) relationships rather than behavioral and interregional competition relationships.

To summarize, DRI has the capability for making reasonably accurate livestock price-quantity projections at the national level, but questionable capability for making regional projections.

Summary of Existing Models

Criteria used for model evaluation along with a summary of how each model measured up to the criteria are given in Table 1. For comparative purposes, a budgeting approach (as suggested in section3) and the Haynes-Adams timber model are also evaluated in Table 1. The Haynes-Adams model is similar in concept to the DRI model, but has only a few equations whereas the DRI model has several hundred equations.

Only the budgeting approach will provide reasonably accurate estimates of the livestock supply curve (upper panel, figure 2). Then, FS rangeland demand functions can be derived by subtracting per-unit production costs from projected livestock prices.

Of the existing models, the DRI econometric model appears to be the best alternative for projecting livestock prices.

TABLE 1. SUMMARY EVALUATION OF EXISTING MODES

Evaluation Criteria	MODEL				
	NIRAP	Heady's National LP Model	DRI Econometric Model	Haynes-Adams Timber Model	Budgeting (Proposed)
Adequacy for projections of demand for FS range	poor	poor	fair, but not regionalized	not applicable	very good, but other approaches must be used to project livestock prices
Relative cost of projections	moderately expensive	very expensive	moderately expensive	moderately inexpensive	reasonably inexpensive
Model based on positive or normative economics	some of both-mostly ad hoc	normative	positive	positive	normative
Regional aggregation and disaggregation	top-down	bottom up[1/]	national only for the livestock component	bottom-up	bottom-up
Reliability of projections	highly questionable	highly questionable[2/]	good[3/]	probably good	just as reliable as cost of production budgets
Ability to estimate future values of independent variables	tied in with OBERS	very limited	good	none	none
Consistency of model with economic theory	inconsistent with elementary theory	consistent except for arbitrary flexibility constraints	so-so	so-so	consistent with long-run profit maximization
Simplicity of model	complex	complex	moderately complex	simple	simple
Availability of data	good	poor	good but expensive	good	partially available from Kerry Gee's budgets
Adequacy of data base	acceptable	difficult to access because he will not release all data. Some technical production coefficients are guesstimates	acceptable	not applicable	
Linkages to non-livestock sector	linked, but see other comments	linked to major ag. commodities	linked with a regionalized crop model and a national hay model	not applicable-but not linked to non-timber sectors	linked if livestock price projections are based on consideration of non-livestock sectors
Structural or forecasting model	hodge podge	structural	forecasting	structural	hybrid, depending on livestock price projection model

Footnotes on following page.

Cont. Table 1--Notes

1/ Projections for producing regions, which are the foundation of Heady's model, could be aggregated to regions that would closely correspond to the nine FS regions.

2/ There are two issues in this case, one empirical and one theoretical. The empirical issue concerns the base-line model results. At the national level, base-line results appear realistic. However, for smaller regions, the results are not as realistic. At the producing region level, the results (which are seldom released) are sometimes ridiculous, and without the arbitrary flexibility constraints in the model, some results would be absurd.

Aside from the empirical validity of the model, the projections are reliable only to the extent that "what ought to be" corresponds to "what is" or "what will be".

3/ DRI's track record for short-run price projections is about as good as any other firm or agency that is in this business but, as in the case of all other models, we have no objective basis to assess the reliability of DRI's long-run projections.

Not shown in Table 1 are two models that are similar to the DRI model. One is a USDA livestock model, while the second is a regionalized crop and national livestock econometric-simulation model developed by Collins and Taylor.[4/] Both of these models are probably less accurate than the DRI model, but may be much less expensive to use. The Collins-Taylor model is free, and scenarios can be evaluated for $10-20.

5. Suggested studies

A critical issue that must first be addressed is whether livestock production on FS rangeland is associated with the intra-marginal (lower) segment of the supply curve for livestock. If this is the case, wide fluctuations in economic conditions will not influence the amount of FS rangeland utilized as long as grazing fees are at, or below, market rates. Moreover, none of the models discussed previously will be of much use in RPA demand assessment or in determining appropriate grazing fees. Since we believe that livestock production on rangeland is less costly than use of other forage sources, we suggest the following three-part study.

To ascertain the relative economic position of livestock produced from range forage, one component of the proposed study would involve a comparative analysis of livestock production costs on FS range, private rangeland, improved pasture and other forage sources. In addition, the analysis would examine opportunity costs in each of the above cases.

[4/] Information on the model is given in a draft report to EPA by G. S. Collins and C. R. Taylor entitled "Econometric-Simulation Models for Major Field Crops and Livestock."

Information obtained from the two components of this proposed study, combined with livestock price projections, should allow us to come to grips with the demand-pricing issue. The complete cost of production study could be done in two years at a cost of $30,000 to $50,000 plus overhead charges (if any). The DRI model appears best suited for livestock price projections. The DRI subscription fee is $17,000/year. Included in this package are standard projections for ten quarters into the future. Projections for different scenarios cost $100-200 per scenario, while long-run projections have an additional cost.